NATIONAL RENEWABLE ENERGY LABORATORY
ENVIRONMENTAL REPORT
for
1995 and 1996

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Executive Summary

The National Renewable Energy Laboratory (NREL) is owned by the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy (EE). NREL is operated by the Midwest Research Institute under the direction of the DOE Golden Field Office (GO). NREL is the nation's primary laboratory dedicated to the research, development and commercialization of economically viable renewable energy and energy efficiency technologies.

This reports represents a summary of the environmental protection program for calendar years 1995 and 1996. It includes site characterizations, confirmation of compliance with applicable environmental standards and requirements, and a discussion of environmental protection efforts at NREL.

Since NREL's research activities are unlike typical manufacturing operations, in that there are no large quantity or routine effluents or emissions generated, routine environmental monitoring of the effluent or emission streams is not conducted. This approach is supported by the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Public Health and Environment (CDPHE). However, EPA and CDPHE require that NREL hold permits for certain emissions and discharges from construction activities, and hold identification numbers for waste generation and drinking water quality. NREL complies with applicable Federal and state requirements. In addition, NREL and GO work cooperatively with state and local regulatory bodies regarding any potential emissions not covered by permits.

In the past, NREL has monitored groundwater quality, wastewater effluent, ambient air particulates, and surface/storm water in accordance with the NREL Environmental Monitoring Plan (NREL, 1994). The purpose of these monitoring activities were to establish baseline environmental data. In keeping with DOE's shift towards risk based, cost-effective approaches to management of sites, NREL and GO have agreed to a revised monitoring approach. This approach incorporates the concepts of risk assessment of NREL operations and is consistent with regulatory requirements. NREL's main program areas are highlighted in the following paragraphs.

The most active portion of the environmental protection program is the management of NREL facilities' hazardous waste streams. NREL has four separate sites that have the potential to produce limited quantities of hazardous materials. Each of the four sites has a Resource Conservation and Recovery Act (RCRA) waste generator identification number issued by the State of Colorado. Two of the sites, the South Table Mountain and Denver West Office Park locations, are classified as "small quantity generators," generating less than 1000 kg of waste per month. The other two sites, the Joyce Street Facility and the National Wind Technology Center, are classified as "conditionally exempt small quantity generators," generating less than 100 kg of waste per month. NREL facilities also handle other nonregulated waste streams in accordance with the EPA's concepts of reduce, reuse, recycle and disposal.

NREL facilities no longer have any underground storage tanks. Instead, NREL facilities store diesel for emergency generator and research use in above-ground storage tanks. Currently, there are seven above-ground storage tanks for diesel fuel. There is one additional above-ground storage tank for fuel alcohol produced by the Process Development Unit (PDU) pilot-plant operation.

All potential sources of air emissions from laboratory and facility operations are minor sources. They are not permitted, with the exception of two side-wide fugitive dust permits: one for the STM site and another for the NWTC. Typical potential sources include boilers, emergency generators, experimental laboratory hoods, pilot scale research projects, and small pieces of equipment with gasoline or diesel engines.

As NREL is a DOE-owned facility and uses limited quantities of low level radioactive materials, the requirements of 40 CFR 61, Subpart H, National Emission Standards for Hazardous Air Pollutants, apply to our operations. These requirements involve demonstration of compliance with the radionuclide emission limit of an effective dose of 10 mrem/yr to any member of the public. NREL demonstrates compliance with the established limit by using the "COMPLY" computer model. The 1995 calculated potential dose to the nearest member of the public was 0.044 mrem/yr and the 1996 calculated potential dose was 0.005 mrem/yr. Because the dose is calculated rather than measured, it represents a potential or estimated dose rather than an actual dose. Other radiological sources at NREL include three x-ray diffraction machines and three sealed-source level gauges.

Domestic water for the NWTC site is provided by NREL. The state has issued a public water supply identification number for the drinking water supply at the NWTC. Water is transported to the NWTC from another state-approved public water supply. NREL performs testing on the water in accordance with state requirements. Drinking water at all of NREL's other sites is provided by a community water system registered with the state.

NREL is currently classified as a nonindustrial water user by the local sewer district. Consequently, NREL is not required to obtain a permit for its wastewater effluent or to monitor the effluent at this time. NREL has no point source discharges to the environment. However, a "Notice of Intent" was filed with the EPA for coverage under the General Permit for Stormwater Discharge Associated with Construction Activity for activities at the National Wind Technology Center, with effective coverage beginning in July of 1994. A similar Notice of Intent was filed with EPA in February of 1995 for the STM site.

The results of four years of groundwater monitoring indicate that groundwater beneath the STM site is uncontaminated. Based on the uncontaminated nature and slow flow rates of the groundwater, routine monitoring has been discontinued.

During the two-year reporting period, NREL facilities had four environmental occurrences. One involved an EPA-initiated cleanup of a commercial waste disposal site used by NREL. The other three were related to potential exceedences of wastewater discharge limits. An investigation was conducted into each one of these events in order to develop lessons learned and implement corrective actions to prevent recurrence. None of the events have resulted in employee exposure, compromise of public safety and health, or degradation of the environment.

Implementation of the environmental protection program at NREL has resulted in relatively stable activities from an environmental perspective. There have been no significant operational upsets and no adverse impacts to the environment as a result of NREL activities.

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List of Acronyms

AFUF	Alternative Fuels User Facility
APEN	Air Pollution Emission Notice
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
DOE	Department of Energy
DOE/GO	Department of Energy/Golden Field Office
DWOP	Denver West Office Park
EA	Environmental Assessment
EPA	Environmental Protection Agency
ES&H	Environment, Safety and Health
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act
FONSI	Finding of No Significant Impact
FTLB	Field Test Laboratory Building
GO	U.S. Department of Energy, Golden Field Office
HFSF	High Flux Solar Furnace
IUF	Industrial User Facility
JSF	Joyce Street Facility
MSDS	Material Safety Data Sheet
MSW	Municipal Solid Waste
MW	Monitoring Well
MWRD	Metro Wastewater Reclamation District
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
NWTC	National Wind Technology Center
OSHA	Occupational Safety and Health Administration
OTF	Outdoor Test Facility
PCB	Polychlorinated Biphenyls
PDU	Process Development Unit
PM-10	Particulate Matter (10 microns or less)
PVWSD	Pleasant View Water and Sanitation District
QA	Quality Assurance
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RFETS	Rocky Flats Environmental Technology Site
RQ	Reportable Quantity
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SERF	Solar Energy Research Facility
SERI	Solar Energy Research Institute
SOP	Safe Operating Procedure
SPPP	Stormwater Pollution Prevention Plan

List of Acronyms (continued)

SQG	Small Quantity Generator
SRRL	Solar Radiation Research Laboratory
STM	South Table Mountain
TCLP	Toxicity Characteristics Leaching Procedure
TLD	Thermoluminescence Dosimeter
TOC	Total Organic Carbon
TOX	Total Organic Halogen
TPQ	Threshold Planning Quantity
TSCA	Toxic Substance Control Act
TSD	Treatment, Storage and Disposal
VOC	Volatile Organic Compound
WPA	Works Progress Administration

1.0 Introduction

This section provides a brief overview of the mission and principal research activities, a basic description of the sites, and a general discussion of the environmental features.

1.1 NREL Mission and Principal Activities

The Solar Energy Research Institute (SERI) was created in 1977 as the nation's primary laboratory dedicated to the research and development of economically viable solar and renewable energy technologies, and to facilitate the commercialization of these technologies. On September 16, 1991, SERI was designated as the National Renewable Energy Laboratory (NREL). The Laboratory is operated for the U.S. Department of Energy's (DOE) Office of Energy Efficiency and Renewable Energy, by the Midwest Research Institute of Kansas City, Missouri. Major research at NREL is conducted in the broad topical areas of photovoltaics (PV), alternative fuels, industrial technologies, wind technology, basic sciences, analytic studies, building and energy systems, utility programs and transportation programs.

In the area of utility technologies, specific disciplines under study at NREL include the following: PV, which is the direct conversion of sunlight to electricity using solid-state materials; wind energy; solar thermal electric, which explores ways to convert the sun's thermal energy into electricity; biomass electric, in which electricity is produced from biomass resources; and superconductivity research, such as the development of new deposition methods for thin-film superconductors. NREL manages a DOE program to produce hydrogen from renewable energy sources. Hydrogen is used extensively for chemicals, food processing and oil and gas processing.

Industrial technologies applications that are the subject of NREL research include solar thermal detoxification, the development of methods that use the sun's energy to destroy hazardous waste and process materials; waste management activities that involve finding better methods to convert waste materials to useful products and methods to convert waste to energy; and biobased materials and plastics recycling, which involves the identification of new materials that are either biobased or combinations of biobased and synthetic that perform as well as conventional metals and plastics.

NREL research is also directed toward transportation technologies. The Biofuels Program is engaged in the development of technologies for converting biomass materials to alternative transportation fuels such as ethanol and methanol. The Fuels Utilization Program is establishing a base for using such fuels in both conventional and advanced heat engines.

Building technologies research is also performed at NREL. The focus of this work is on the development of advanced perimeter thermal-control systems to reduce building heating, cooling, lighting and ventilation loads.

NREL also conducts research directed at artificial photosynthesis, basic photoelectrochemistry, modified semiconductor electrodes, and synthesis of novel organometallic compounds useful as catalysts for photoconversion processes. These studies have a goal of producing useful fuels and chemicals using direct sunlight-driven chemical reactions.

Another energy-related research activity at NREL is related to the Municipal Solid Waste Program (MSW). The MSW Program goal is to make productive use of municipal solid waste as an energy resource.

1.2 Site and Facility Description

NREL facilities occupy four separate locations in Jefferson County, Colorado, near the city of Denver. The four facilities are the Denver West Office Park (DWOP), the South Table Mountain Site (STM), the Joyce Street Facility (JSF) and the National Wind Technology Center (NWTC). The DWOP and STM sites are approximately 2 miles (3.2 km) east of Golden and 12 miles (19.3 km) west of central Denver. The NWTC is adjacent to the DOE Rocky Flats Environmental Technology Site, approximately 15 miles (8.9 k) north of the STM site. The JSF is located at 6800 Joyce Street, approximately 5.5 miles (8.8 km) north of the DWOP and STM sites. Figure 1.1 illustrates the locations of the four sites on a regional map. Figure 1.2 provides a more detailed map of the DWOP and STM sites, and Figure 1.3 gives a more detailed map of the NWTC site.

The STM and NWTC sites are the two main sites where research operations are conducted. These two sites will be addressed separately in the discussion of environmental features. The DWOP is leased space used primarily for laboratory work and administrative functions. The JSF is also a leased space that is used primarily for storage space. Neither the DWOP or JSF will be addressed in Sections 1.3 and 1.4, *Environmental Features*.

1.3 Environmental Features - South Table Mountain Site

1.3.1 Historical/Cultural Resources

Two formal surveys of historic and cultural resources have been performed on the STM site. These surveys were completed in 1980 and 1987. As a result of these surveys, three historical sites were recognized as significant cultural resources that should be preserved. These sites include an open-air amphitheater, a stone bridge spanning a natural drainage channel adjacent to the amphitheater, and a stone and concrete ammunition bunker below the amphitheater site. The three structures were constructed during the Works Progress Administration (WPA) era in the 1930s. Through NREL's efforts, these sites have been added to the National Register of Historic Places (National Register). A complete Cultural Resource Management Plan has been prepared to ensure the protection of these historic structures. NREL also participated in an interagency survey of South Table Mountain and Camp George West to identify historic structures and sites eligible for nomination to the National Register.

1.3.2 Geology, Soils and Hydrogeology

The STM sites is a roughly triangular parcel of land occupying portions of the top, sides and lower south-facing slopes of South Table Mountain. South Table Mountain is composed of sedimentary rocks below a basalt lava cap, which is quite resistant to erosion. The South Table Mountain feature is a mesa that stands about 150 meters above the adjacent lowlands. It was formed by the erosion of weak sedimentary rocks surrounding the mesa's erosion resistant lava cap. Below the lava caprock, the sedimentary rocks are part of the Denver Formation that consists of layers and lenses of claystone, sandstone and conglomerate. Sedimentary rocks of the Arapahoe Formation underlie the Denver Formation.

Both the Arapahoe and Denver Formations are considered to be aquifers in portions of the Denver Basin. The Denver Formation underlies the areas on which most NREL construction has taken place. Groundwater on the STM site occurs primarily in the weathered and fractured silts and sands of the Denver Formation. There may also be some groundwater in the form of perched aquifers below the basaltic lava cap on the South Table Mountain and within the materials above the Denver Formation, which are largely the result of stream deposits. Groundwater flow on the site is in a southeasterly direction.

Figure 1-1. Regional Map

Figure 1-2. Detailed Map of Denver West Office Park and South Table Mountain

Figure 1-3. Detailed Map of National Wind Technology Center

The soil covering the top of South Table Mountain is Lavina Loam. A loam is composed of a mixture of clay, sand, silt and organic matter. The loan on the mesa top is a shallow, well drained clayey soil. Soil on the upper side slopes of South Table Mountain is also a loam consisting of extremely stony soils with significant amounts of clay. Much of the remainder of the site, including the area designated for major development, has a deep, well drained soil referred to as Denver clay loam. It consists of clayey material containing some calcium carbonate. There are also two smaller soil areas on the southwestern portion of the site, both of similar character to other site soils: cobbly clay loam and very stoney clay loam.

1.3.3 Surface Hydrology

The STM site normally receives about less than 50 cm (20 in) of precipitation per year. Most of this precipitation is in the form of rainfall from early spring through early fall. The monthly precipitation during this warm season is from 2 to 8 cm (1 to 3 in). Precipitation from November to March is normally in the form of snow.

About 90% of the surface drainage off the site, both the mesa top and across the lower portions of the site, is in the southerly direction toward Lena Gulch (a tributary of Clear Creek). Two drainageways on the eastern most portion of the site are intercepted by Welch Ditch, which ultimately flows into Lena Gulch.

There is no permanent stream flow on the STM site. Only occasional flow derived from extended periods of precipitation, usually during the late winter and early spring, is found in the drainage channels with seasonal springs evident along some of the mesa slopes.

1.3.4 Vegetation

NREL began conducting a vegetation survey of the entire STM site during the summer of 1992, and completed the survey during the 1993 field season. Two primary vegetation types were identified on the STM site: grasslands and shrublands. The most common plant communities on the STM site are mixed grasslands. They comprise over 80% of the vegetation on the site. These communities are generally dominated by short- and mid-grass species. Two primary upland shrub communities occur on the STM site: mountain mahogany shrublands and shrubland occurring in drainages lacking active channels. The mountain mahogany shrubland is composed primarily of thickets of mountain mahogany with understory grass and forb species similar to those of the short-grass communities. Mountain mahogany shrubland is found on the shallow soils of the mesa, particularly in areas of exposed volcanic rock. The upland shrubland communities occurring along gullies and drainages are dominated by a number of shrubs that can also form dense thickets. These shrubs can also be found in drainages with associated wetlands. Recent field surveys have identified limited wetland/riparian areas along drainages. The wetland communities identified on the STM site are a very minor component of the total vegetation cover, accounting for less than 1% of the emergent wetlands. These shrub communities can form dense thickets within the confines of the drainage.

1.3.5 Wildlife

The STM site represents an island of relatively undisturbed native range habitat compared to nearby segments of urban development. Livestock grazing is not authorized on the STM size. A wildlife survey was conducted on the site during 1986 and 1987. Mammals seen using the site during the survey were the mule deer, coyote, grey fox, red fox, raccoon, longtailed weasel, striped skunk, spotted skunk, badger, bobcat, mountain lion, rabbits and yellow-bellied marmots. Seventeen species of birds were observed on the STM site, along with two species of raptors: kestrels and two nesting pairs of red-tailed hawks. NREL personnel have reported

numerous sightings of snakes as well as a golden eagle. A variety of amphibian species are expected to inhabit the area. No upland game or endangered species were observed on the STM site during the year-long wildlife survey.

1.4 Environmental Features - National Wind Technology Center

1.4.1 Historical/Cultural Resources

Three formal surveys of historic and cultural resources have been performed on the NWTC site. These surveys were completed in 1989, 1991 and 1995. As a result of these surveys, five historical finds were discovered. These finds included the remains of a spring house, remains of a potential corral, remains of foundations and pieces of barbed wire. None of these finds are eligible for listing on the National Register. There have been no paleontological (fossils), prehistoric, or Native American resources identified on the NWTC site.

1.4.2 Geology, Soils and Hydrogeology

The NWTC site is located on a plain formed by stream deposits. The uppermost geological layer beneath the site is known as the Rocky Flats Alluvium (RFA). It is composed of cobbles, coarse gravel, sand and gravelly clay. Below the RVA is the Laramie Formation, Fox Hills Sandstone and Pierre Shale. These rock formations consist primarily of claystones with some siltstones. Unconfined groundwater flow occurs in the RFA toward the east/southeast and small perched zones are common. Groundwater occurs as confined aquifers in the deeper bedrock formations (EG&G Rocky Flats, Inc., 1992).

The NWTC has a strongly developed soil defined as a very cobbly, sandy loam. The soil is characterized by a large amount of cobble and gravel in the soil volume, and a subsoil dominated by clay (USDA, 1995).

1.4.3 Surface Hydrology

The NWTC normally receives about 50 cm (19.6 in) of precipitation per year. Approximately half of the precipitation falls from March to June in the form of rainfall. Winter precipitation is primarily in the form of snowfall.

The area surrounding the NWTC site is drained by five streams: Rock Creek, North Walnut Creek, South Walnut Creek, Woman Creek and Coal Creek. Rock Creek flows eastward and is located southeast of the NWTC. North Walnut Creek and South Walnut Creek flow eastward into the Great Western Reservoir. Woman Creek drains eastward into Standley Lake. Coal Creek flows in a northeasterly direction across the City of Boulder open space north of the NWTC.

The majority of the NWTC drains into a tributary to Rock Creek. Some of the northern portions of the site drain into Coal Creek or its tributaries.

1.4.4 Vegetation

The NWTC is predominantly characterized by dry pasture vegetation of several varieties. There are also four small areas of moist, low scrub or moist meadow. Vegetation characteristics of the site include perennial grasses and forbs, shrubs and cacti.

Along the northwestern ridge is a Ponderosa pine woodland area. Vegetation found in this area includes woody species with an understory of grasses, forbs and shrubs.

1.4.5 Wildlife

Prior to 1975, the NWTC site was heavily grazed by livestock, damaging a majority of the native vegetation. A wildlife survey was conducted in 1992 for the entire Rocky Flats Plant and buffer zone area, including the NWTC. Signs or tracks of bears and mountain lions were identified. Other mammals known to feed at the site are mule deer, coyotes, desert cottontail rabbits, white-tailed jackrabbits, black-tailed jackrabbits, deer mice, prairie voles and thirteen-lined ground squirrels. Approximately 20 different species of birds were signed at or near the site. Raptor (birds of prey) surveys were conducted at the NWTC in 1994 and 1995, and identified seven raptor species on or in the vicinity of the site. No upland game or endangered species are known to inhabit the NWTC site.

1.5 Demographic Information

According to 1990 census data, the Denver metropolitan counties -- Denver, Boulder, Jefferson, Adams, Arapahoe and Douglas -- had a population of 1,848,319. The six-county population is expected to increase to approximately 2,093,977 by the year 2000. The 1990 population of Jefferson County was 438,430, an increase of 17.9% over the 1980 data, and Golden has a population of 13,116, representing an increase of 7% over the 1980 figures. Jefferson County's population growth is expected to increase at the same rate as the 6-county area to 485,048 by the year 2000.

During most of the 1980s, the unincorporated portion of the region grew more rapidly than municipalities. Scattered, low-density urban sprawl has become a dominant feature of the area's landscape and is expected to characterize future regional growth.

1.6 Land Use

The STM site is a 120-hectare (300-acre) area predominantly bordered by open grassland zoned for recreation and light-commercial activity. A vacant parcel of Camp George West is located adjacent to and south of the central portion of the STM site. Portions of the community of Pleasant View are located immediately to the south and west of the western portions of the STM site. Offices, shops and a tree nursery owned by the Colorado State Forest Service are located at the far western edge. Undeveloped state land and a Colorado State Highway Patrol pursuit driver training track are located along the northwestern boundary of the STM site. Jefferson County open space wraps around the northern and the eastern edge of the site. Portions of the DWOP lie to the east. Figure 1.4 illustrates general land use in the vicinity of the STM site. Figure 1.5 is the site plan for the STM site.

The NWTC facility occupies a 112-hectare (280-acre) area surrounded by open grazing land, with the exception of operations at the Rocky Flats Environmental Technology Site, which borders the NWTC to the southeast. Figure 1.6 depicts zoning designations that show general land use in the vicinity of the NWTC site.

The JSF is located in a commercial area surrounded by agricultural land, residential neighborhoods and small businesses.

Figure 1.4. Land Use in Vicinity of the South Table Mountain Site

Figure 1.5. Site Plan for the STM Site

Figure 1.6. Zoning and Land Use in the Vicinity of the NWTC Site

1.7 Topography

The STM site and DWOP are approximately four kilometers east of the front range of the Rocky Mountains. The STM site is situated on the top and south facing slopes of South Table Mountain, an isolated mesa that stands about 150 meters (492 ft) above adjacent valley areas. The mesa top of South Table Mountain slopes gently to the south. A prominent cliff rims the top, ranging from approximately 9 meters (30 ft) high on its south side to over 45 meters (148 ft) high on the north side. Elevations on the STM site range from 1,743 meters (5717 ft) above sea level near the southeast corner to 1,844 meters (6048 ft) at the northernmost point of the site. Most NREL facility developments are located on the base and lower slopes, approximately 1,675 meters (5494 ft) above sea level.

1.8 Climate

The climate for the geographic region of NREL operations is classified as semi-arid, typified by sparse precipitation, low relative humidity, abundant sunshine, and large daily and seasonal temperature variations.

The area experiences moderate precipitation, with average annual rainfall less than 50 cm (20 in). Almost half of the annual precipitation occurs from March to June. Summer showers contribute 33% of the annual precipitation total. Precipitation begins to decrease significantly in the fall, and reaches the minimum during winter. Winter is the driest season, contributing less than 10% of the annual precipitation, primarily in the form of snowfall.

Spring is a season of unstable air masses with strong winds along the foothills and the Front Range. The highest average snowfall occurs in March, and the STM site can generally expect to experience at least one heavy snowstorm with totals exceeding 15 to 25 cm (6 to 10 in.).

The solar radiation (sunlight energy) of the region is excellent for outdoor research and testing of solar energy conversion devices and systems. Sunshine is abundant throughout the year and remarkably consistent from month to month and season to season.

2.0 Environmental Nonradiological Program Information

2.1 Introduction

The objective of NREL's environmental management program is responsible stewardship of the environment, both on its DOE-owned sites and leased properties. NREL strives to protect the natural environment by minimizing or eliminating any adverse environmental impacts resulting from NREL activities. The Laboratory's environmental program includes components to address waste, air, water, natural resources and land and soil issues, among others. Descriptions of the components of the environmental nonradiological program are provided in the following sections of this chapter. A description of the environmental radiological program is presented in the next chapter.

2.2 National Environmental Policy Act (NEPA)

Proposed research projects and proposed activities connected with operation of NREL's facilities are reviewed to evaluate the potential for adverse impacts on the surrounding environment in the spirit of the National Environmental Policy Act (NEPA). The extent of documentation prepared for these reviews is commensurate with the level of evaluation needed. No written documentation is prepared for actions that are purely administrative in nature. The review for most other actions is documented in the project file, and Environmental Assessments (EA) have been prepared for site development activities.

There were no environmental impact statements produced for NREL facilities in 1995 or 1996. Preparation of a site-wide EA for the NWTC was completed in 1996. As the NWTC has been in use for wind energy research since 1977, the proposed action for the EA is continued use of the site for testing of renewable energy technologies, primarily in the area of wind research. In addition, some use of the space for warehousing and storage of NREL-owned equipment is also under consideration.

Numerous environmental evaluations were completed in 1995 and 1996 for which categorical exclusions were given (categorically excluded activities are those, which by their nature have been determined by DOE to have no significant environmental impacts). These environmental evaluations were performed for new research activities and subcontracted work, including minor site construction, modification and demolition projects, and research and development at non-DOE facilities. None were found to have a significant environmental impact. Where necessary, mitigation measures (such as erosion control measures for construction work) are being implemented to ensure that NREL activities create no significant impact on the environment.

2.3 Waste Management

2.3.1 Pollution Prevention and Waste Minimization

As a facility that focuses on renewable technologies, NREL is committed to responsible environmental stewardship. A significant part of this effort is pollution prevention. NREL's Pollution Prevention Plan is consistent with the EPA's hierarchy of preventing or reducing pollution at the source; recycling or reusing waste materials that cannot be prevented; and environmentally safe treatment and disposal of waste that cannot be prevented, recycled or reused.

NREL's environmental management programs are designed around this pollution prevention philosophy. NREL's pollution prevention program has been combined with the waste minimization program to reduce

resource use, reduce the toxicity and quantity constituents in waste streams, improve product yields, reduce health and accident risk, and reduce waste management and compliance costs. This has the added benefit of reducing chemical inventories and reducing the potential for chemical releases to the environment.

The current pollution prevention program includes training on waste handling, waste minimization and methods to eliminate releases to air, soil or wastewater. In addition, the Environment, Safety and Health Office (ES&H) integrates pollution prevention awareness into NREL activities in a number of ways. The proposed chemical use of a project is evaluated during project planning reviews, and pollution prevention concepts are communicated to the project manager (e.g., substitution of less hazardous chemicals or reducing quantities). All Safe Operating Procedures (SOPs) are reviewed and pollution prevention recommendations are provided. Pollution prevention methods are also communicated in internal NREL publications. An ongoing activity of the ES&H Office is to perform preliminary reviews of proposed research activities before the preparation of the SOP begins. (An SOP is written to describe controls for experiments or activities at NREL facilities that address environmental, safety and health hazards). These early reviews enhance pollution prevention awareness and encourage research staff to implement pollution prevention principles to the maximum extent possible. Office recycling is also a component of NREL's pollution prevention program and is communicated to Laboratory staff through training, internal NREL publications and special posters and meetings.

Research and associated waste generation rates fluctuate based on annual funding from Congress. Therefore, the focus of the NREL program is to minimize its waste volumes on a project or activity basis. Employees in the research organizations who generate hazardous waste are given pollution prevention and waste minimization training. This training emphasizes project planning to look for nonhazardous chemical substitutes and to eliminate overpurchasing. It also presents a brief synopsis of the different types of wastes generated by NREL's activities, characteristics of each waste type, and discusses proper waste-handling practices and record-keeping procedures to promote safe and responsible disposal of the materials. This waste management/waste minimization training is mandatory for all waste generators and is ongoing, with classes held twice each month.

For those employees who do not generate hazardous wastes, training is comprised of an environment, safety and health orientation video that is required for all new permanent and temporary NREL employees and some contractor personnel as well. This video briefly discusses the waste management program at NREL facilities.

As part of its pollution prevention initiative, NREL facilities have established a chemical redistribution program to make chemicals in original containers available to reissue for research activities at no cost. In addition to chemical redistribution, waste oil that has been verified to contain no hazardous contaminants is sent to an oil-recycling firm whenever feasible. Other items that are currently recycled or reused by NREL facilities include lead-acid batteries, styrofoam popcorn and other packing materials, boxes, freon from refrigeration units, cleaning solvents, scrap metal and wooden pallets. NREL sites also send used laser printer cartridges to a reclaimer who reprocesses, refills and redistributes them. NREL facilities offer nonhazardous waste recycling opportunities to all employees, including programs for aluminum cans, newspaper, white and mixed paper and magazines. Occasionally other materials are recycled or sent for reuse on a one-time basis when significant amounts of appropriate materials are no longer needed. There was one such occasion in 1996 when approximately 1045 kg (2300 lb) of nitrate salts were returned to the manufacturer for reuse, thus avoiding disposal. Total amounts of materials recycled during 1995 and 1996 are shown in Table 2.1 for those materials that can be quantified.

Table 2.1 Quantities of Materials Disposed and Recycled[1]
(all values in kg unless otherwise noted)

Material	1995	1996	Notes
Sent for Disposal:			
hazardous waste	5592	3876	
non-regulated waste	1036	5014	increase largely due to oily waste from from 1995 and 1996
PBC-containing material	0	0	
asbestos-containing material	36	0	
low level radioactive waste	9.5	38.6	generated but not yet shipped; 1996 increase due to lab decommissioning
Recycled:			
used oil	0	0	oil disposed because a suitable recycler could not be found locally
solvents (from parts cleaning station)	68	see note	parts cleaning station was not in use in 1996
scrap copper	325	64	
scrap stainless steel	295	18	decrease largely due to decreased lab activity in 1996
scrap ferrous steel	3764	982	
newsprint	26,117	no data	
aluminum	1,739	270	1995 data includes scrap aluminum and aluminum cans; no data on aluminum cans available for 1996
whtie, computer and mixed papers	58,717	no data	
other - batteries	6606	1818	1995 one-time uninterruptable power supply decommissioning
refrigerants	36	11	recovered & cleaned for on-site reuse
pallets	--	91 pallets	no data collected prior to 1996; given to recycler
toner cartridges	--	219 cartridges	1996 data for Jan to mid-Oct; no data collected prior to 1996

[1]Recycling totals for scrap metals decreased in 1996 compared to 1995 levels. This decrease may be the result of reduced laboratory activity due to budget reductions.

2.3.2 Hazardous and Radioactive Waste Management

Hazardous waste generators are classified on a contiguous site basis by the EPA as large quantity, small quantity or conditionally exempt small quantity, based on the amounts of waste that are generated each month at the site. NREL is a research and development laboratory and does not engage in any production activities, therefore, waste generation rates are predominantly controlled by the amount of research activity under way. Based on the quantities of waste generated (less than 1000 kg per month), the STM and DWOP sites are considered small quantity generators (SQG). The NWTC and JSF generate less than 100 kg per month and are, therefore, conditionally exempt SQG sites. This eliminates many of the administrative and record-keeping requirements that other classifications of generators must meet. NREL facilities' waste profile consist of hazardous laboratory chemicals that would be typical of any university laboratory operation. Chemicals in solid or liquid form are collected in each laboratory or at each experimental site. These wastes are periodically collected from the laboratories and prepared by the NREL ES&H Office for off-site disposal.

Hazardous wastes are handled and disposed according to the Resource Conservation and Recovery Act (RCRA). It is NREL's policy to have the majority of its RCRA-regulated wastes incinerated, rather than landfilled, in order to more completely destroy the hazardous constituents and minimize any potential for future public exposure. This treatment and disposal is conducted at an EPA-permitted treatment, storage and disposal facility. In addition, NREL facilities have adopted a conservative waste disposal policy in which materials that are not regulated by RCRA, yet pose a potential hazard, are collected and disposed of as nonhazardous material at a RCRA-permitted disposal facility. NREL sites also dispose of other special wastes, such as asbestos-containing material, in accordance with the appropriate regulations. As discussed in the previous section, NREL facilities incorporate waste minimization practices into its activities whenever possible to minimize the volume and/or toxicity of waste generated by its activities.

NREL facilities also generate a very small amount of low level radioactive waste. The average amount of radioactive waste generated is typically less than 1 cubic meter (about 10 to 20 kg) per year, including packing material. This waste normally consists of personal protective equipment such as gloves and water-based liquids. Radioactive waste is shipped off-site for disposal on an as-needed basis. Details about the types and quantities of radioactive materials used at NREL facilities are provided in Section 4.0

Quantities of materials that were disposed during 1995 and 1996 are listed in Table 3.1. The quantities listed are the figures shown on manifests and other shipping documents, but they are approximations only. The materials are normally not weighed when picked up by disposal or recycling vendors. Typically, a vendor will provide its good faith estimate of quantity based on practical experience.

Under the Federal Facilities Compliance Act, DOE facilities are subject to the federal laws applicable to the management of solid and hazardous waste. NREL, as a federal facility, complies with these laws for all waste operations at the Laboratory.

2.3.3 Waste Sites and Emergency Reporting

No hazardous waste sites have been identified on any of the Laboratory sites. Therefore, many sections of the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) do not apply to NREL facilities. However, NREL sites are subject to the emergency reporting sections of CERCLA that require the reporting of any releases of reportable quantities (RQ) of chemicals. During 1995 and 1996, the Laboratory had no releases to the environment of chemicals reportable under this section.

NREL facilities are also subject to the emergency reporting requirements in Title III of the Superfund Amendments and Reauthorization Act (SARA), also known as the Emergency Planning and Community Right-To-Know Act (EPCRA). These regulations require a facility to notify the State Emergency Response Commission that is subject to emergency planning and notification requirements if any chemicals in the facility's inventory are stored in quantities greater than prescribed threshold planning quantities (TPQs). NREL facilities first became subject to planning and notification requirements in 1988.

There are also reporting requirements in the event of a release of an RQ of any hazardous substance listed by EPCRA. In 1995 and 1996, NREL facilities had no release exceeding the RQ of any reportable material under EPCRA.

NREL provides Material Safety Data Sheets (MSDSs) for chemicals that are stored on-site in quantities greater than TPQs, and provides inventory reporting for these same chemicals in the form of Tier I or Tier II reports to emergency planning and response groups. While NREL facilities currently have no chemicals on-site that exceed TPQs, the Laboratory has submitted MSDSs and Tier II reports in the past when required.

NREL provides emergency response and reporting information to the Jefferson County Emergency Planning Committee (EPC), the State Emergency Response Commission, and West Metro Fire Rescue when requested. The Jefferson County EPC uses Uniform Fire Code hazard categories and threshold reporting quantities rather than those specified in SARA Title III, resulting in a larger number of individual hazard categories and lower reporting thresholds. NREL compiled this information for 1995 and 1996 and has it available on-site. NREL has an active involvement in the emergency planning concepts of SARA Title III, in that the Laboratory currently has an acting member on the Jefferson County EPC, and has been so represented since the EPC's inception.

SARA Section 313 requires that a toxic chemical inventory report (Form R) be filed with EPA for any chemical that is manufactured, processed or otherwise used in quantities exceeding TPQs. As a research and development Laboratory, NREL does not manufacture or process any materials, and during 1995 and 1996, the Laboratory did not use any materials on the Section 313 list in quantities exceeding the 4536-kg (10,000-lb) threshold planning quantity. Therefore, no reporting under Section 313 is required. Although NREL is not a manufacturing facility and does not fall within any of the Standard Industrial Classification (SIC) codes for which Section 313 reporting is required, Executive Order 12856 requires all federal facilities to report regardless of SIC code if the threshold quantities are met.

NREL has not identified any areas within its facilities that contain residual contamination requiring special decommissioning. During 1995, elaborate procedures and documentation for laboratory decommissioning and remodelling were established for the conversion of laboratories to office space in Building 16. Sampling of laboratory areas was conducted when appropriate, and no residual contamination was found. In addition, a Phase I investigation of Building 16 was conducted in 1996 by a subcontractor for Denver West Management, the owner of the building. The audit was required as a part of a refinancing effort. The Phase I audit did not reveal any contaminated areas.

2.4 Water

2.4.1 Drinking Water

Drinking water for the STM, DWOP, and JSF is provided by the Consolidated Mutual Water Company, Inc., a community water system registered with the state. Domestic water for the NWTC site is provided by NREL.

NWTC water is transported from the City of Boulder water supply and stored in tanks until it is delivered at the tap. NREL has two drinking water systems at the NWTC: the first is at Building 251, which began operation in July 1994, and the second is at the new Industrial User Facility (IUF), which began operation in August 1996.

Supplementation disinfection of drinking water in both systems is performed. Water at Building 251 is chlorinated as it is delivered to the tap, and water at the IUF is passed through an ultraviolet disinfection system. Water is tested according to state requirements, and test results are submitted to the Colorado Department of Public Health and Environment for review.

2.4.2 Surface Water Protection

Limited storm water monitoring was conducted at the STM site during the summers of 1992 and 1993 to establish a baseline for surface water quality at NREL's current level of activity and to confirm that NREL's activities were not adversely impacting storm water quality on the STM site. Sampling indicated that NREL's activities are not causing contamination of storm water runoff.

Outdoor research projects are reviewed during the planning stages for potential impacts to surface water. Measures to prevent such impacts are incorporated, as appropriate, into the design for each project. Such control measures could include secondary containment and bermed areas where chemicals will be used, or installation of a cover or roof to protect chemical use and storage areas from precipitation and adverse weather conditions.

Storm Water Pollution Prevention Plans (SPPP) have been written for construction activities on both the STM and NWTC sites. Erosion and sediment controls are implemented according to the plans, and periodic site inspections are conducted to verify that the controls are functioning properly and identify any repairs to the erosion and sediment controls that are needed. Provisions of the SPPPs are implemented through coordination with NREL's construction subcontractors. In 1996, additional ES&H staff members were trained to perform storm water inspections. This results in storm water issues being recognized by these staff members while they are on construction sites for other reasons. Construction projects occurring at the STM site during 1995 and 1996 included the Site Entrance Building, Outdoor Test Facility, additional parking area for the FTLB, installation of a new emergency generator at the Alternative Fuels User Facility, utility upgrades, Thermal Test Facility, FTLB Central Plant, STM site walkway and Shipping and Receiving Facility. Amount NWTC site construction projects for 1995 and 1996 are pad sites and small test buildings, Hybrid Test Facility, data communications upgrades and Industrial User Facility. A number of these projects were begun but not completed during 1995 and 1996.

2.4.3 Ground Water Protection

Because of the sensitive nature of the ground water resources, NREL is careful to evaluate all outdoor projects to confirm that they do not have the potential to impact ground water quality. The Laboratory is quite conservative in the safeguards it insists be present with any outdoor research in order to protect ground water. Safeguards include such things as secondary containment for equipment that could have the potential to leak oil, double wall tanks with leak detection for diesel fuel storage tanks for NREL facilities' emergency generators, and bermed areas to contain experimental materials.

NREL initiated a groundwater monitoring program at its STM site in 1990 to characterize groundwater beneath the site and to confirm that NREL activities were not adversely impacting groundwater quality. Eight

groundwater monitoring wells were drilled in August 1990 to depths ranging from 5.7 to 11.1 m (18.8 to 36.5 ft) below ground surface (Applied Environmental Consulting, Inc., 1990). The wells were distributed over the majority of the developed portions of the STM site at the base of South Table Mountain to obtain samples that accurately represent groundwater quality throughout the site. Four wells were placed upgradient of all NREL activity to provide a good indicator that contaminants were not being transported onto the STM site. The remaining four well locations were placed downgradient of NREL activities to verify that activities had not adversely affected groundwater quality.

Initial groundwater sampling was performed from October to December 1990. Each of the eight wells was sampled quarterly for the first five quarters of monitoring. The decision was made to reduce the frequency of sampling because of the lack of contamination and the slow estimated groundwater flow rates, which are between 0.0018 and 0.0046 m/day (0.006 and 0.015 ft/day).

Sampling and analyses of groundwater were performed on an annual basis from 1992 and 1994 with an expanded list of organic compounds. Sampling was done for metals, inorganic parameters, volatile and semi-volatile organics, radioisotopes and herbicides and pesticides. Sampling results were consistent with expected background levels for parameters for which background concentrations are established (primarily inorganics). The few random detections of different compounds that occurred from time to time were generally at trace levels and did not consistently occur. These detections were attributed to incidental variability in laboratory results. The four-year sampling program gave no indication of any contamination problems at on the STM site. The only detection of a compound that exceeded groundwater standards was lead, which was in one upgradient well during the final sampling event in 1994. The lead concentration in the well was 76 micrograms per liter, while the standard is 50 micrograms per liter. The Laboratory is currently evaluating follow-up sampling on the STM site's remaining wells to compare results with initial characterization sampling.

In 1993, three wells were permanently closed due to construction activities. The remaining five wells are currently inactive.

NREL facilities currently conduct no groundwater monitoring at the STM site, as there are no activities conducted that pose an unusual risk to groundwater quality. If NREL had reason to suspect a groundwater quality problem, additional monitoring would be done.

NREL facilities currently conduct no groundwater monitoring at its leased DWOP site, as there are no activities that pose an unusual risk to groundwater quality. If NREL had reason to suspect a groundwater quality problem, the issue would be addressed with Denver West Management. DWOP management contracted with an engineering firm to conduct a cursory groundwater monitoring study in 1988 adjacent to the NREL-leased buildings. Two monitoring wells were drilled and groundwater samples were analyzed for VOCs, cyanide, 13 priority pollutant metals, acid and base/neutral extractables, PCBs pesticides and phenols. All metals were below 1 ppb and none of the remaining analytes were detected with the exception of trace amounts (<5 ppb) of trichlorofluoromethane and 1,1-dichloroethane, two common industrial solvents. NREL acquisition records indicated that the Laboratory had never purchased either chemical prior to the 1988 study.

The NWTC currently has no open or active groundwater wells. There was a water supply well that provided water to Building 251 when the site was operated by DOE's Rocky Flats Office. In 1993, one round of water samples were taken from this well and the associated water distribution and treatment system for the purpose of determining the most feasible alternative for water supply to the site. Based on the sampling results, it was determined that the maintenance and repairs required to make the existing well and treatment system effective were extensive, and there was an indication of the potential for trace organic compounds in the water. Therefore, when DOE's Golden Field Office assumed landlord responsibility for the site in 1993, the

connection between the building and the well was severed. The water supply well was plugged and abandoned in accordance with state regulations by an NREL subcontractor in 1996. Potable water is currently transported to the site, as described in Section 2.4.1. NREL has not done any other groundwater sampling at the site. Groundwater sampling will be conducted if future activities pose a risk to the groundwater quality.

2.4.4 Wastewater

Wastewater from NREL's STM and DWOP facilities flows into the Pleasant View Water and Sanitation District's system and ultimately to Metro Wastewater Reclamation District's (Metro) treatment plant. Wastewater from the JSF flows into the City of Arvada's collection system where it is also routed to Metro's treatment plant. The NWTC is not connected to a sewer system, but has two septic systems that include tanks and absorption fields for the treatment of wastewater.

NREL has no direct wastewater discharges to the environment at the STM, DWOP or JSF. NREL facility wastewater is discharged to Metro through the sanitary sewer system. NREL facilities are currently classified as nonindustrial water users at these sites because they discharge less than 97,633 L (25,000 gal) per day from each connection to the sewer system, and their effluent does not contain any toxic pollutants. As nonindustrial users, NREL sites do not need a permit from Metro for sewer discharge, and monitoring for pollutants in wastewater is not required. It is NREL policy that hazardous chemicals are not to be discharged to the sewer system and NREL staff are trained in this policy. In addition, NREL sites have design criteria for waste drains in lab areas to minimize the possibility of a hazardous material discharge. These criteria include measures such as raised lips on sinks in laboratory exhaust hoods where chemicals might be used, no floor drains in laboratory areas unless a specific need can be shown, and caps for any floor drains that are installed in lab areas.

Although not required, random grab sampling and analyses of NREL facility wastewater were performed in the 1980s, but only minor concentrations of pollutants were detected. Quarterly wastewater monitoring at the DWOP leased facilities and at the STM site was initiated in mid-1992 and continued throughout 1994 (Applied Environmental Consulting, Inc., 1992c) to demonstrate that NREL facilities' wastewater effluent met local publicly owned treatment works, state, and EPA standards. Both 24-hour composite and grab samples were collected and demonstrated that discharges from Building 16 i n the DWOP and the FTLB met all regulatory standards.

Manual grab sampling was also performed at the Building 15 photography laboratory wastewater sump with the same frequency as the other sampling during 1992 and 1993. The sump was decommissioned in 1994 and direct sampling of photo lab wastewater streams was conducted throughout 1994 to verify that standards were met.

2.5 Air Quality

All potential sources of air emissions from laboratory and facility operations are minor sources and are not permitted. These potential sources include boilers, emergency generators, experimental laboratory hoods, pilot scale research projects and small pieces of equipment with gasoline or diesel engines. Projected emissions for all of these sources are either below thresholds for air permitting or the state has reviewed the operation and determined emissions to be negligible in terms of impacts to the environment.

Most chemicals at NREL facilities are used in small quantities on a laboratory scale for its research and development activities. NREL has compiled an air emission inventory that lists potential sources and quantities of air emissions for various air contaminants at NREL facilities. According to NREL's worse case scenario,

the estimated maximum quantity of noncriteria reportable pollutants emitted from NREL's research activities is approximately 1361 kg (1.5 tons per year). This estimate was made assuming that the entire volume of all reportable chemicals used in one year was volatilized and exhausted to the environment. This is a conservative estimate as large portions of the chemicals used in research experiments are ultimately found in liquid and solid products of the experiments. For comparison, a dry cleaner typically emits an average of 4536 to 9072 kg (5 to 10 tons) of organic chemicals per year.

Ambient air particulate monitoring was begun in May 1992 and continued through the end of calendar year 1993 on the STM site to monitor potential impacts of Solar Energy Research Facility (SERF) construction. After 1.5 years of sampling, no significant impact on ambient air quality due to SERF construction activity was found. In addition, ambient air at the STM site was below the state's annual maximum limit of 50 micrograms per standard cubic meter with two exceptions and was always well below the 24-hour maximum limit of 150 micrograms per standard cubic meter.

NREL provides a facility (space at its mesa top Solar Radiation Research Laboratory) to the State of Colorado for one of its permanent ozone monitoring stations. The station was operated throughout the summer of 1993 as a temporary station and became a permanent monitoring station in 1994. Maximum ozone levels detected at the NREL site are normally below the federal regulatory limit.

During 1995 and 1996, NREL phased out all of its fire extinguishing system using halon, in accordance with Montreal Protocol initiatives to reduce the use of ozone depleting substances. Five systems were decommissioned containing a total of 268 kg (718 lb) of halon. All of the halon from these systems was collected and provided to Western Area Power Administration for reuse at government facilities.

The only National Emission Standards for Hazardous Air Pollutants (NESHAP) that typically apply to NREL activities are the asbestos NESHAP and the standard for radionuclides from DOE facilities. The demolition and renovation portion of the Federal and accompanying state asbestos standard provides guidelines for the occasional asbestos demolition or renovation work undertaken by the Laboratory. Most asbestos at the Laboratory is non-friable (not easily crumbled) and is limited in extent to items such as transite board in laboratory ventilation hoods and vinyl asbestos floor tile. NREL construction documents specifically exclude the use of asbestos containing materials from new construction or remodeling. The radionuclide standard is discussed further in Section 3.1.3.

2.6 Natural Resources

2.6.1 Endangered Species

The Endangered Species Act provides for the designation and protection of wildlife, fish and plant species that are in danger of extinction and preserves the ecosystems on which these species depend. A wildlife survey was completed on the STM site in 1987 (The FORUM Associates, Inc., 1987a), at which time no threatened or endangered species or candidate wildlife species for endangered designation were found. A complete vegetation survey of the STM site was completed in 1994 that identified no threatened or endangered plant species on the STM site.

No threatened or endangered species of either plants or animals have been identified on the NWTC site. A vegetation survey to verify the accuracy of previously collected data was performed in 1994 and no threatened or endangered plant species were identified at that time.

Field research into avian use of the NWTC was conducted during 1994 and 1995 in an effort to identify potential impacts on birds from wind-turbine research. While several species of raptors, including red-tailed hawks, kestrels and a great-horned owl were noted on the site, they were primarily transient in nature. The NWTC appears to be used primarily for loafing and hunting, although one pair of kestrels nested in an old concrete pole during the spring. Birds of prey of concern, such as eagles, generally fly in excess of 152 m (500 ft) over the site. No significant impacts to the birds from NREL activities were found.

2.6.2 Historic Preservation

Three historic resources have been identified on the STM site. One is an amphitheater that was constructed during the Works Progress Administration era in the 1930s. The second site is a stone footbridge leading to the amphitheater and constructed during the same time period. The third site is a stone-faced ammunition igloo. NREL has taken measures to protect these structures from damage by nominating the structures to the National Register and the Colorado Register of Historic Places. The nominations were approved in 1993.

A cultural-resources survey was conducted at the NWTC during 1994. Although the site is thought to be part of the Old Lindsay Ranch, no historic resources were identified on the site.

2.6.3 Floodplain Management

According to maps generated by the Jefferson County Department of Highways and Transportation as part of its urban drainage studies, NREL's STM site does not contain any floodplains, and to date, no floodplains have been identified at the NWTC.

As a best-management practice, however, all construction activities that may cross a drainage channel are designed to meet the 100-year flood control standards (designed to withstand the equivalent of a 100-year flood).

Actions undertaken by NREL at subcontractor facilities are assessed for potential impacts on floodplains at those sites through the use of an environmental checklist.

2.6.4 Protection of Wetlands

Limited wetland areas totaling less than 0.4 ha (1 ac) occur on the STM site in the drainage bottom located east of the SERF. These are narrow, linear wetlands supporting spikerush, baltic rush, sedges, bluegrass, hemlock and field mint. These wetlands will be protected from adverse impacts as site development continues.

Wetland areas at the NWTC are extremely limited in extent as well. These areas, along the site's eastern boundary, total less than 0.4 ha (1 ac).

Actions undertaken by NREL at subcontractor facilities are assessed for potential impacts on wetlands at those sites through the use of an environmental checklist.

2.6.5 Integrated Pest Management (IPM)

The Colorado Weed Management Act requires landowners to control certain species of weeds and prevent their spread to adjacent properties. These species are leafy spurge, diffuse knapweed, spotted knapweed and Russian knapweed. Jefferson County also requires management of Canada thistle, musk thistle and purpose

loosestrike. Three additional species have the potential for listing on Jefferson County's noxious weed list. They are dalmation toadflax, yellow toadflax and alyssum.

In the summer of 1996, a survey of weed species was conducted on the STM site. Species of concern, densities and their distribution across the site were identified. There were no large infestations of any weed species identified. Canada thistle was the weed that was most prevalent with minor infestations of diffuse knapweed, dalmation toadflax, musk thistle and alyssum present.

During the 1995 field season, a survey of weed species, densities, and distribution was conducted at the NWTC. The noxious weed species of greatest concern is diffuse knapweed, largely because it is widespread in extent on the site. Other species present on the site include leafy spurge, Canada thistle and dalmation toadflax. In July 1995, the State of Colorado released a species of root-boring beetle, *sphenoptera jugoslavica*, as an experimental biological control that attacks knapweed on the site. Attempts to locate evidence of the beetle's presence one year following release were unsuccessful, so it appears that the beetle did not become established at the site.

In 1996, an integrated weed management plan was prepared that outlines various types of control strategies for all the noxious weed species of concern at the NWTC. In addition to satisfying state requirements regarding weed control, several other benefits will result from implementation of the plan. Research sites will be more accessible, wildlife habitat will improve and soil erosion will be reduced because native vegetation grows more densely than weed species. The management of weeds also demonstrates NREL's dedication to the philosophy of good stewardship with the public lands we are entrusted to manage. Implementation of the NWTC Weed Management Plan began in the fall of 1996 with education of staff at the site regarding the need to control noxious weeds and control measures prescribed by the plan.

NREL also occasionally applies herbicides to sidewalks and paved areas adjacent to buildings. NREL uses relatively low toxicity pesticides intended for general use, making applicator certifications necessary for NREL employees. The Laboratory has written and follows an SOP for the use of pesticides and herbicides by NREL's Site Operations Center. Pesticides or herbicides classified by federal regulations for restricted use are not applied by NREL personnel. Certified subcontractors are used to apply any restricted-use pesticides that are needed, such as spraying road base before paving. These subcontractors must first provide NREL with documentation that they hold the proper applicator certification.

Pesticides ar used to control rodents inside buildings as needed and to control insects (wasps) in areas where they pose a threat to NREL staff and visitors. The Laboratory uses pesticides that, compared to other available products, have a relatively low persistence in the environment and a relatively low toxicity to humans and wildlife while still providing control of the target pest.

2.6.6 Land and Soils

As many of NREL's research activities occur within enclosed buildings, the risk of contamination of surrounding land is minimal from these projects. Outdoor research is carefully assessed for various types of environment, safety and health risks during the planning and design phase of each project. As a result of these risk assessments, appropriate controls are recommended and implemented to protect the environment from foreseeable incidents.

Other activities that have the potential to impact the environment are construction, as a part of NREL's site development efforts, and outdoor equipment, such as transformers and diesel storage tanks associated with building operation and research. Controls are put in place on NREL's construction sites to mitigate the short-term disturbance created. These controls are more fully described in Section 2.4.2, *Surface Water Protection*, and Section 2.5, *Air Quality*.

All of NREL facilities' oil-containing transformers have either been tested or certified to be "non-PCB-contaminated," which significantly reduces the environmental hazard posed by this equipment. PCBs are polychlorinated biphenyls, a material that causes significant damage to wildlife and PCB-contaminated material is defined by law to be material with 50 to 500 ppm PCB concentrations (materials with PCB concentrations greater than 500 ppm are considered "PCB-containing").

Underground storage tanks for diesel fuel can pose significant environmental risks, largely because they cannot be visually inspected for leaks. In November 1995, a tightness test was performed on NREL facilities' only remaining 3785 L (100 gal) underground storage tank that stores diesel fuel for the emergency generator at the FTLB on the STM site. No leaks were detected. NREL removed the tank in 1996. It was replaced by an above-ground storage tank. No evidence of leaking was found when the tank was excavated and removed.

NREL facilities have five above-ground tanks that store diesel fuel for emergency generators, both at the STM site and at the NWTC, and one smaller tank used for research purposes. The inventory is presented in Table 2.2.

Table 2.2 NREL Above-Ground Storage Tank Inventory

Size, in L (gal)	Contents	Use	Date On-Line
3785 (1000)	diesel	SERF Emergency Generator	10/93
22,712 (6000)	ethanol, 50%	PDU Product Storage	1994
2347 (620)	diesel	PDU Emergency Generator	8/95
2120 (560)	diesel	FTLB Emergency Generator	6/96
1514 (400)	diesel	IUF Emergency Generator	installed 9/96
151 (40)	diesel	A251 Emergency Generator	1980 (approx.)

Several important safeguards have been incorporated into NREL's policy for tank management to prevent any accidental releases of diesel fuel from the storage tanks. These safeguards include both mechanical safeguards, such as double wall tanks with sensors that result in an alarm if the inner tank wall is leaking, overfill protection and spill protection; and procedural safeguards such as periodic inspections and tank filling procedures.

2.7 Environmental Training

Two types of ongoing environmental training classes are conducted on site for NREL employees. As described in Section 3.3, waste management and minimization training is required of all waste generators, both laboratory staff and those involved in facility operation and maintenance. The course is taught by the ES&H Office staff members whose speciality is the management and minimization of all types of waste materials. This training

is provided as part of orientation for all new employees who may generate waste. Periodic refresher training is also required.

NEPA implementation training was also provided in 1995 to NREL staff members who are responsible for planning and performing activities that could have potential environmental impacts. In this course, NREL's policies and procedures for NEPA implementation was presented and a systematic method for evaluating various types of activities for environmental impacts was provided. In 1996, this training was streamlined and the NEPA Handbook was distributed to staff in lieu of course attendance. This allowed staff to make more efficient use of the time they would otherwise spend in training and provided them with materials that can be used for reference when performing evaluations.

In addition to the laboratory-wide training described above, training is also provided to individual centers or other groups upon request in the areas of waste management and minimization, NEPA and environmental compliance.

Training courses provide staff with an understanding of ES&H issues and policies. This knowledge provides staff with an avenue to effectively raise any issues of concern that may arise in the future. Any such employee concerns are investigated and resolved by ES&H staff and any other internal or external consulting experts that are needed.

An initiative to validate the effectiveness of NREL's risk assessment program, including the program's effectiveness in identifying and controlling environmental hazards, was instituted in October 1996. The validation effort will continue into 1997 and the results will be presented in the 1997 Site Environmental Report.

3.0 Environmental Radiological Program Information

3.1 Introduction

All radioactive material at NREL facilities are handled according to NREL's Radiological Control Program. Elements of the program include a radiological control organization, a radiation safety policy and control manual, safe operating procedures, safe work permits, radiological control areas and postings, monitoring, training and purchasing controls for radioactive materials.

There are no nuclear operations at NREL sites. All radiation sources are used/stored in facilities located on the STM site. These include three x-ray diffraction machines at the SERF, two sealed source level gauges at the AFUF used on pilot scale processes to measure the level of material inside process tanks and a third sealed source level gauge in storage. In addition, a few laboratories at the FTLB occasionally use small quantities of radioisotopes for biological labeling.

3.2 Radiological Emissions and Doses

3.2.1 Radioactive Effluent Data

No radioactive air-emission monitoring is conducted because of the extremely low usage of radioactive material at NREL facilities. The Laboratory's radioactive inventory as of February 1997 is less than 7.6 mCi, far less than most university or hospital radiochemistry laboratories.

In 1995, the quantity of radioisotopes used included carbon-14, sulfur-35 and phosphorus-32. No radioisotopes were used at NREL facilities during 1996. Although NREL had radioactive materials on-site in storage (in "inventory"), none were actually used in experiments in 1996. NREL's total inventory of radioactive isotopes as of February 1997 is as follows:

Isotope	Activity
C-14	7.051 mCi (2.6x 10^8 Bq)
S-35	0
H-3	0.500 mCi (1.9 x 10^7 Bq)
P-32	0
Total	7.551 mCi (2.796 x 10^8 Bq)

3.2.2 Sampling for Radioactivity

Personal monitoring by way of thermoluminescence dosimeters (TLDs) is performed on NREL personnel who are working with any of the x-ray machines or in the labs where P-32 radioisotopes handled or stored. C-14, S-35 and H-3 cannot be detected using the TLDs. Each worker wears a TLD that is sent to a laboratory for analysis at least once every quarter. TLDs would be sent for analysis immediately if an exposure problem were suspected. Two types of TLDs are used at NREL facilities: lapel dosimeters, that provide a measure of total effective dose equivalent (whole body); and ring dosimeters, that provide a measure of the arms and hands dose. A whole body dose is generally measured for staff working with P-32 radioisotopes and arms and hands doses are generally measured for staff working with x-ray diffraction equipment.

Monitoring of equipment and facilities for removable contamination is performed in the laboratories where radioactive isotopes are used. These surveys are conducted by the researchers working with the isotopes after they conclude their experiments. Wipe tests are performed on any laboratory surfaces that could have become contaminated by the radioisotope work at least monthly and more frequently if needed. These wipes are analyzed using a scintillation counter. The ES&H Office also performs routine wipe samples every calendar quarter in the labs where radioisotopes are used.

Both types of monitoring aim to ensure that the work environment in the laboratories using radioisotopes are maintained in accordance with prudent health and safety practices and DOE standards. NREL's Radiation Safety Policy and Radiological Control Manual prescribe proper storage, handling, contamination control and disposal procedures for radioactive materials.

For 1995, 21 staff members were monitored for whole body dose and there were 24 staff monitored for arms and hands dose (many staff members were monitored for both). One of the 21 staff monitored for whole body dose received a total effective dose equivalent (whole body) of 10 mrem (0.1 mSv); the dose measured for the remaining 20 staff was zero. None of the 24 staff members wearing ring dosimeters received any measurable arms and hands dose--all of these measurements were zero. In 1996, only 3 staff members were monitored for whole body dose, and 19 were monitored for arms and hands dose. The number of staff monitored for whole body dose decreased significantly because no radioisotopes were used during 1996 and radioisotope users make up the majority of staff monitored for whole body dose. All total effective dose equivalent measurements were zero for the lapel dosimeters. One person wearing a ring dosimeter received an arms and hands dose of 30 mrem (0.3 mSv) and the remaining individuals' arms and hands doses were zero. These are very low doses compared to the DOE yearly allowable total effective dose equivalent for a single individual of 5000 mrem (50 mSv), and the DOE yearly allowable arms and hands limit of 50,000 mrem (500 mSv) for a single individual. The results of all past analyses on dosimeters worn by NREL personnel are similar to the 1995 and 1996 results. Results of TLD monitoring are summarized in Table 3.1.

Table 3.1 Summary of Personal Monitoring Results
(all values in mrem, with mSv in parentheses)

Year	Sum of Total Effective Dose Equivalents (Whole Body)	Sum of Arms & Hands Doses
1995	10 (0.1 mSv)	0
1996	0	30 (0.3 mSv)
DOE Yearly Allowable Limit for Each Individual	5,000 (50 mSv)	50,000 (500 mSv)

The three X-ray diffraction machines are registered with the State of Colorado and are inspected every two years by a state-licensed surveyor. The surveyor inspects and certified the X-ray machines and audits NREL's program for radiation safety in connection with operating the machines. X-ray diffraction machine inspections were performed in 1995 and the equipment was recertified for another two years.

3.2.3 Reporting Potential Dose to the Public

DOE Order 5400.5, "Radiation Protection of the Public and the Environment," established radiation air emission limits for DOE facilities. Radiation air emission limits for DOE facilities are regulated by Section 112

of the Clean Air Act as implemented by 40 CFR 61, Subpart H, established by the EPA. According to 40 CFR 61, Subpart H, all DOE facilities must annually demonstrate compliance with the radionuclide emission limit, which states that emissions to the ambient air may not exceed an amount that would result in any member of the public receiving an effective dose of 10 mrem/yr (40 CFR 61.92).

Given the extremely small quantities of radioactive materials used at NREL sites, no stack sampling or perimeter radionuclide monitoring is performed at any of NREL's four sites. Therefore, NREL demonstrates compliance with 40 CFR 61, Subpart H, by using the COMPLY computer model (40 CFR 61.93(a)) to calculate radionuclide emissions and public dose. The COMPLY dosimetry model and its resulting evaluation are designed to very conservative and simplistic and are intended for use by facilities, such as NREL, where the sources are extremely small. Because the result is calculated rather than measured, it represents a potential or estimated dose rather than an actual dose to the public. According to the computer model, the potential dose to the public for 1995 was 0.0044 mrem/yr (4.4×10^{-5} mSv/yr). Although no radionuclides were used during 1996, much of the inventory is in unsealed containers, so the potential dose to the public for 1996 was calculated as though the entire inventory went up the exhaust stack. The potential dose for 1996, as modeled by COMPLY, was 0.005 mrem/yr (5.0×10^{-5} mSv/yr). As both the 1995 and 1996 potential doses to public were well below the standard of 10 mrem/yr (0.1 mSv/yr), NREL is in compliance with the NESHAP standards for radionuclides.

These calculated radionuclide emissions are extremely conservative overestimates of exposure because the formula for the calculation assumes that the entire quantity of the open containers of radionuclides used in 1995 was released and the entire inventory was released in 1996; that the wind was blowing each radionuclide in the direction of the nearest receptor 25% of the time; and that the receptor at NREL facilities' fence line raised and consumed all his own milk, meat and vegetables at home. In addition, in performing the calculation, NREL assumed that each open container of radioisotopes was used at one time. In fact, because the amounts used in any one experiment are so small, the laboratory's inventory of radioactive materials is normally used over a number of months of years. Table 4.2 outlines the calculated maximum individual dose to the closest member of the public in comparison with DOE and EPA standards. Table 3.3 presents the maximum potential quantities of radionuclides released to the environment. These are the conservative values used in the COMPLY model. It should be noted that these values represent quantities of all open containers from which radioisotopes were used during 1995; it does not include radioisotopes that are in inventory in unopened containers. In 1996, the quantity of all containers, both opened and unopened, was used in the calculation.

Also in 1995, NREL evaluated its potential collective dose to the public within 80 km of the Laboratory. This collective dose provides an indication of the radiation hazard posed by NREL operations to the general population in the vicinity of the site. NREL facilities have no radioactive liquid effluents; therefore, the potential for exposure is limited to the airborne pathway only. As stated above, the potential maximum whole-body effective dose equivalent to the nearest resident at NREL facilities' fence line is 0.0044 mrem/yr (4.4×10^{-5} mSv/yr) from airborne emissions in 1995 and 0.005 mrem/yr (5.0×10^{-5} mSv/yr) in 1996, as calculated by the EPA-approved COMPLY computer model. This value is extraordinarily low compared with the regulatory standards listed in Table 3.2. Because of the potential exposure levels involved, an assessment of the degree of hazard associated with NREL facility operations was performed by calculating a maximum potential individual dose at 80 im using the conservative COMPLY model, rather than modeling a collective dose. According to COMPLY, an individual at 80 km from the NREL STM site, subject to the assumptions described above and using the 1995 usage data, would have the potential to receive a maximum whole-body effective dose equivalent of 0.0000018 mrem/yr (1.8×10^{-8} mSv/yr) due to NREL facility operations. As stated above, the regulatory limit for public doses is 10 mrem/yr (0.1 mSv/yr). The potential whole-body effective dose equivalent to an individual at 80 km from the NREL STM site due to operations in 1996 is 0.00000078 mrem/yr (7.8×10^{-9} mSv/yr).

For comparison purposes, natural background radiation levels to which each member of the public is normally exposed over the course of a year is 27 mrem from cosmic radiation, 28 mrem per individual from terrestrial sources (soils and rocks) and 200 mrem from naturally occurring radon sources.[2] Estimates of exposure from manmade radiation sources, including medical and dental X-rays, consumer products (smoke detectors, lantern mantels, etc.) and nuclear testing average about 5 mrem yearly.

Table 3.2 Calculated Maximum Individual Radiation Dose from NREL Facilities
(all values in mrem/yr, with mSv in parentheses)

Maximum Individual Dose **	**EPA Allowable Dose Limit (via ambient air)**	**DOE Allowable Dose Limit* (via all exposure modes)**
at NREL fence line:		
1995--0.0044 (4.4×10^{-5})	10 (0.1)	100 (1)
1996--0.005 (5.0×10^{-6})	10	100
at 80 km from NREL:		
1995--0.0000018 (1.8×10^{-8})	10	100
1996--0.00000078 (7.8×10^{-9})	10	100

* DOE 5400.5

**Natural background radiation level on the STM site, as measured by an informal beta-gamma survey, is approximately 0.01 mrem/hr to 0.02 mrem/hr (0.0001 to 0.0002 mSv/hr), which is approximately 876 mrem/yr to 1752 mrem/yr (8.76 to 17.52 mSv/yr).

Table 3.3 Maximum Potential Levels of Radionuclides Released to the Environment from NREL Facilities During 1995 and 1996

Air Releases:

		Maximum Potential Release*	
Isotope	Half-life	1995	1996
C-14	5730 years	0.59 mCi (2.2×10^7 Bq)	7.05 mCi (2.6×10^8 Bq)
S-35	88 days	0.64 mCi (2.4×10^7 Bq)	0
P-32	14 days	0.75 mCi (2.8×10^7 Bq)	0
H-3	12.3 years	0	0.50 mCi (1.9×10^7 Bq)

Water Releases:

None

* In 1995, the activity of all open containers of each radioisotope was used to represent the maximum potential release. In 1996, the activity of all containers in NREL facilities' inventory was used as the maximum potential release.

[2]Merril Eisenbud, *Environmental Radioactivity from Natural, Industrial and Military Sources*, 3rd Edition, Academic press, Inc., 1987.

3.3 Unplanned Radionuclide Releases

There were no unplanned releases of radioactive substances at NREL facilities during 1995 or 1996.

3.4 Radiological Environmental Monitoring

As discussed above, there was no radiological environmental monitoring performed at NREL sites during 1995 or 1996 due to the extremely small quantities of radioisotopes used the Laboratory.

4.0 Summary of Permits and Registrations

Table 5.1 summarizes all of NREL's environmental or environmental-related permits for the operations at all four sites. Below is a general discussion of each of the main permit groupings.

The State of Colorado has primacy over the Source Conservation and Recovery Act (RCRA) program. NREL has a RCRA waste generator ID number for each of its four separate sites. DWOP Building 16's small-quantity generator's ID number was issued in 1980. The STM site's small quantity generator's ID number was issued in 1988. The JSF and NWTC sites were issued conditionally exempt small-quantity generator ID numbers in 1992 and 1993, respectively.

NREL has a Public Water Supply Identification (PWSID) number for its drinking water systems at the NWTC. The PWSID number was issued by the Colorado Department of Public Health and Environment on July 5, 1994. The identification number was originally issued for the water supply system at Building 251 and a second system was added at the new IUF in 1996. Both systems operate under the same CDPHE identification number.

In 1995, NREL applied for site-wide coverage under EPA's general permit for storm water discharge associated with construction activity for the STM site; this permit continues in effect. Site-wide coverage under the general permit became effective at the NWTC on November 30, 1994, for storm water discharge associated with construction activities.

NREL holds site-wide fugitive dust permit applications, issued by CDPHE, for construction activities on the NWTC and STM sites. The terms of the permits run until January 1, 2000. Permit conditions are outlined in Fugitive Dust Control Plans for each site, and periodic site inspections are conducted in conjunction with stormwater inspections to verify that control measures are functioning properly. Some of the specific construction projects to which these permits applied in 1995 and 1996 are listed in Section 3.4.2.

Four of NREL facilities' chillers are registered with CDPHE under the state's Ozone Depleting Substances Program. Refrigeration equipment that is 100 horsepower or greater and that uses a refrigerant on the state's list is required to be registered. Two of the registered chillers are at the FTLB and two are at the SERF. A All refrigeration equipment (even if it is too small for registration) must be serviced, maintained and repaired by a state-certified technician. NREL has certified technicians on staff that perform these tasks. Records must also be kept on the registered equipment regarding quantities of refrigerant added and withdrawn from the systems, as well as any catastrophic releases. NREL did not have any catastrophic releases during the two-year report period.

Two of NREL facilities' above-ground storage tanks are registered with the state. Both contain diesel for emergency generators. The one located at the SERF is 1000 gallons and the one behind the PDU holds 620 gallons.

NREL holds two permits from the Bureau of Alcohol, Tobacco and Firearms. One is an Industrial User's Permit for the use of laboratory-grade alcohol in laboratory or operations activities. The second permit is an Alcohol Fuel Producer's Permit for fuel alcohol produced by NREL's PDU pilot plant. Both permits must be renewed annually through payment of a special occupational tax.

Table 4.1 Summary of NREL's Environmental Permits and Registrations

Permit Type	Permit Description	Location	Issuing Agency	Comments	Permit ID Number	Issue Date	Expiration or Renewal Date
Hazardous Waste	Generator Identification Number	STM	CDPHE		CO3890090076		None
Hazardous Waste	Generator Identification Number	DWOP	CDPHE		CO4890000017		None
Hazardous Waste	Generator Identification Number	JSF	CDPHE		COD980805162		None
Hazardous Waste	Generator Identification Number	NWTC	CDPHE		COD983802448		None
Drinking Water	Public Water Supply Identification Number	NWTC	CDPHE	Hauled drinking water (2-non community systems)	230860	7-6-94	no expiration provided all requirements are met
Stormwater	Site-wide permit for discharge from construction activity	STM	U.S. EPA	Coverage under General Permit	COR10A21F (DOE) COR10A20F (MRI)	Feb. 1995	9-9-97
Stormwater	Site-wide permit for discharge from construction activity	NWTC	U.S. EPA	Coverage under General Permit	COR10A14F (DOE) COR10A13F (MRI)	July 1994	9-9-97
Air Emission	Boiler (Hydrotherm)	FTLB	CDPHE	Rescinded 3/97	83JE399	Nov. 30, 84 (initial aprvl)	N/A
Air Emission	Boiler (Cleaver-Brooks)	FTLB	CDPHE	Rescinded 3/97	88JE098	Dec. 23, 88 (final aprvl)	N/A
Air Emission	Site-wide permit for fugitive dust from construc-tion activity	NWTC	CDPHE		95JE496L	Sept. 22, 95	January 1, 2000
Air Emission	Site-wide permit for fugitive dust from construc-tion activity	STM	CDPHE		95JE497L	Sept. 22, 95	January 1, 2000

Permit Type	Permit Description	Location	Issuing Agency	Comments	Permit ID Number	Issue Date	Expiration or Renewal Date
Ozone Depleting Substance	Registration of Refrigeration Equipment - 2 chillers	SERF	CDPHE		00407-001, 00407-002	1995	Annual renewal each January
Above-Ground Storage Tank	Registration	SERF	Colo. Dept. of Labor	Diesel for emergency generator	1-001198 tank no. 1	5-98	Annual renewal each January
Above-Ground Storage Tank	Registration	PDU	Colo. Dept. of Labor	Diesel for emergency generator	1-001198 tank no. 2	5-96	Annual renewal each January
Bureau of Alcohol, Tobacco and Firearms	Alcohol Fuel Producer Permit	AFUF	ATF	Alcohol produced from PDU experimental process	AFP-CO-00255	May 30, 94	Annual renewal each July 1
Bureau of Alcohol, Tobacco and Firearms	Alcohol Fuel User Permit	All NREL facilities	ATF	Tax-free usage of alcohol in research and operations	TF-C-0331	1985	Annual renewal each July 1

5.0 Environmental Occurrences

There were no significant releases of pollutants or hazardous substances during 1995 and 1996. No reports were made to the Headquarters Emergency Operations Center or the Coast Guard National Response Center. There were four DOE reportable occurrences per DOE 5000.3B (one unusual occurrence and three off-normal events) that had potential environmental implications; these were reported to DOE/GO. However, no release of a reportable quantity of hazardous material to the environment was involved in any of these four cases, so NREL was not required to notify emergency response agencies.

In May 1995, corrosion of an experimental vessel resulted in the discharge of fermentation broth from NREL's Process Demonstration Unit that contained levels of chromium and molybdenum possibly exceeding reporting thresholds of local wastewater districts. The vessel was taken out of service to be refurbished and additional inspections were implemented to prevent recurrence. No injuries or exposures resulted from this incident.

In June 1995, NREL was contacted by EPA Region VIII regarding a site clean-up and response action at the site of a hazardous materials disposal broker used in the past by NREL. EPA took control of the site when the site was abandoned. NREL had shipped low-level radioactive waste to the site. Five drums shipped to the broker from NREL had not been properly disposed by the broker. The drums contained liquid and solid laboratory debris that may have been contaminated with trace amounts of carbon-14, phosphorus-32 and sulfur-35. In addition, there were two anti-static devices from laboratory analytical balances containing polonium-210. All drums were intact and were removed from the clean-up site and returned to NREL for storage pending disposal.

In July 1995, a leak occurred in the SERF process cooling water system. The system was treated with molybdenum and the discharge occurred through the SERF wastewater system. Although fresh water was continuously added to the system throughout the duration of the leak, discharged water still likely exceeded the local wastewater districts' discharge limit for molybdenum. The leak occurred because of a defective valve in the system. The system was shut down as soon as possible for repairs and the use of molybdenum-based corrosion protection additives in NREL facility process cooling water systems was discontinued. A molybdenum-free additive is now used.

In April 1996, a "near miss" occurred at the PDU ethanol pilot plant involving about 400 gallons of fermentation broth containing a low level of viable recombinant organisms. The organisms were not human pathogens and were classified as Class I by the National Institutes for Health (NIH). Class I is the lowest NIH biological risk level classification. The organisms were used to enhance the fermentation of agricultural products to facilitate the production of ethanol. The broth was being transferred to a receiving vessel when it inadvertently entered a holding sump through an open discharge valve on the receiving vessel that should have been closed before beginning transfer. The broth collected in the fermentation sump that was designed to contain spills. The broth was then automatically pumped to the neutralization tank, which is the vessel from which discharge to the sewer system normally occurs. The problem was discovered and the open-valve was closed. No wastewater containing the viable recombinant organism was discharged. The organisms were killed before discharge, as is required by NIH guidelines and wastewater district regulations. The problem was caused by inadequate procedures. To prevent reoccurrence, written procedures will be updated every time the process configuration is changed and two verification checks have been added to the transfer procedure in which the operator physically walks the system down to verify proper configuration and integrity of the process circuit.

6.0 Quality Assurance

6.1 Quality Assurance Program

The quality and validity of all environmental monitoring programs depend on the implementation of strict quality assurance and data validation controls. An NREL facility-wide Quality Assurance (QA) manual, titled *NREL Management Program*, for research, development and demonstration work, as well as ES&H activities, has been completed (NREL 1993c). The NREL ES&H Office has also prepared a quality assurance plan for all environmental sampling and analysis under its control (NREL 1993b). This document is titled *Environmental Engineering Section Quality Assurance Plan*. Where appropriate, NREL follows EPA-prescribed protocols for environmental sampling and analysis.

In preparation for each monitoring program, as well as nonroutine monitoring events, comprehensive quality assurance/quality control procedures (QA/QC) to be followed by field and laboratory personnel in collecting and analyzing samples are included in the monitoring work plans. In addition to QA measures incorporated in the monitoring procedures, periodic QA audits of subcontractor personnel performing environmental sampling are performed by the ES&H Office, in accordance with the QA Plan. For any additional environmental monitoring or surveillance work to be performed, QA procedures will be prepared specifically for each type of monitoring as part of the initial planning phase of the project.

The QA manual, plan and procedures are tiered documents. The manual outlines general laboratory policy, the plan applies the policy to environmental sampling and analysis and the procedures describe program-specific quality assurance requirements.

6.2 Laboratory Certification

All laboratory analytical work resulting from environmental monitoring is conducted by a qualified subcontractor laboratory. It is the responsibility of the ES&H Office to select qualified subcontractor laboratories for the analysis of environmental monitoring samples. A combination of onsite inspection, QA verification and credential review are the primary mechanisms for determining qualifications. Laboratories chosen for future environmental monitoring sample analyses will be subject to equally careful scrutiny and verification measures with respect to their qualifications and QA procedures.

Samples are collected by NREL ES&H staff or by subcontractor personnel. Samples are delivered to the laboratory for analysis personally by the sampler or they are shipped in coolers by overnight delivery.

Barringer Labs was selected for groundwater monitoring sample analyses from 1990 through 1993. Evergreen Analytical Inc., was selected for the analysis of 1993 surface and wastewater samples and 1994 groundwater samples. Accu-Labs Research, Inc., was selected for ambient air monitoring sample analyses in 1993. As there are no current routine monitoring programs underway, there is no laboratory under contract at this time.

6.3 DOE Laboratory Quality Assurance Program for Radioactive Material

As described in Section 4.1, NREL conducts only two types of industrial hygiene monitoring for potential radiation exposure. No environmental radiation monitoring is conducted at NREL facilities because of the very limited use of radioisotopes. NREL does not participate in the DOE-interlaboratory QA program for radiological monitoring because laboratory analysis is not performed in-house.

6.4 Data Verification

Sampling and analytical data received from laboratories undergo a data review process to ensure the validity and accuracy of the information before the results are used. Each data set received will be reviewed using the following procedures:

- Verify that the proper sampling method and the recommended analytical procedures have been used.
- Verify that the analytical results are reasonable given the known site conditions, sampling methods and analytical method.
- Determine whether or not the results could have been affected by interferences.
- Evaluate QA/QC data provided by the lab (for example, results of blanks, duplicates and spikes).
- Review the potential sources of error and confirm that these errors have not occurred.
- Compare data to previously obtained analytical results when previous data are available.

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